State of California

Memorandum

To William H. Crooks, Executive Officer
California Regional Water Quality Control Board
Central Valley Region
3443 Routier Road
Sacramento, CA 95827-3098

Date March 8, 1994

Place

From **Department of Pesticide Regulation** - 1020 N Street, Room 100
Sacramento, California 95814

Subject 1994 Rice Pesticide Program

Enclosed is information that addresses efforts to control the presence of rice pesticides in Sacramento Valley surface waters. It includes a review of the 1993 rice pesticide program and conditions that affected its outcome and results of the water quality monitoring program. It also includes a description of a program proposed for implementation in 1994.

I understand that the Board will consider the proposed 1994 rice pesticide program at a meeting on March 25. Marshall Lee, of my staff, will be available to participate at this meeting and to present information to the Board.

If you have any questions regarding the enclosed information, please contact me or have your staff contact Marshall Lee at (916) 324-4269.

James W. Wells
Director
(916) 445-4000

Enclosure

SURNAME			

Department of Pesticide Regulation
Information on Rice Pesticides
Submitted to the Central Valley Regional Water Quality Control Board
March 8, 1994

Programs have been implemented since 1983 to reduce discharges of the rice herbicides molinate (Ordram®) and thiobencarb (Bolero®) into surface waterways. In 1990, the objectives of these control efforts were clarified and expanded, following the adoption of amendments to the Central Valley Regional Water Quality Control Board's (Regional Board's) water quality control plan. This plan established performance goals for molinate and thiobencarb, beginning in 1990, and for the insecticides carbofuran (Furadan®), methyl parathion, and malathion, beginning in 1991.

The information provided reviews the factors affecting quantities of molinate, thiobencarb, carbofuran, methyl parathion, and malathion discharged to agricultural drains and the Sacramento River and efforts to meet 1993 performance goals. A summary of pertinent water quality monitoring efforts is also provided. Programs are proposed which will help control discharges of molinate, thiobencarb, carbofuran, methyl parathion, and malathion from rice fields to levels that comply with both 1994 performance goals and the Basin Plan's water quality objective for toxicity.

1993 PROGRAM

PROGRAM DESCRIPTIONS

Molinate

The 1993 molinate program was designed to meet water quality objectives and the 1993 performance goal of 10 parts per billion (ppb) molinate in Central Valley surface waters. The program was implemented using restricted material permits conditioned to mitigate water quality problems associated with use. The conditions included:

1. All water treated with products containing molinate had to be retained on the site of application for at least 28 days following application unless:

a. the treated water was contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system could discharge 29 days following the last application of molinate within the system.

    1. If the system was under the control of one permittee, treated water could be discharged from the application site in a manner consistent with product labeling.

2. If the system was under the control of more than one permittee, treated water could be discharged from the application site nine days following application.

b. the treated water was on acreage within the bounds of specific geographic areas that discharged negligible amounts of rice field drainage into the Sacramento River or its tributaries until fields were drained for harvest. All water on fields treated with molinate had to be retained on the treated acreage for at least eight days following application.

2. Fields not specified in 1.a. and 1.b. could resume discharging field water 29 days following application at a volume not to exceed two inches of water over a drain box weir. Unregulated discharges from these fields could then resume after seven days.

3. The county agricultural commissioner could authorize the emergency release of tailwater seven days following application following a review of a written request (Appendix 1) which clearly demonstrated that the crop was suffering because of the water management requirements. Additionally, the requester was required to describe preventative action that would obviate the need for future emergency releases. Under an emergency release variance, tailwater could be released only to the extent necessary to mitigate the documented problem. Those issued an emergency release had to submit to the county agricultural commissioner a report (Appendix 2) indicating the time and duration of the emergency release and data that could be used to calculate the total amount of water released during the emergency release. Only one emergency release can be granted in each three-year period unless the reason for the emergency release is excessive rainfall, high winds, or other extreme condition that cannot be moderated with management practices.

Thiobencarb

The 1993 thiobencarb program was designed to meet water quality objectives and the 1993 performance goal of 1.5 ppb thiobencarb in Central Valley surface waters. The program was implemented using restricted material permits conditioned to mitigate water quality problems associated with use. The conditions included:

1. All water treated with products containing thiobencarb north of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County had to be retained on the treated fields for at least 30 days following application unless:

a. the treated water was contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system could discharge 20 days following the last application of thiobencarb within the system.

1. If the system was under the control of one permittee, treated water could be discharged from the application site in a manner consistent with product labeling.

2. If the system was under the control of more than one permittee, treated water could be discharged from the application site 7 days following application.

b. the treated water was on acreage within the bounds of specific geographic areas that discharged negligible amounts of rice field drainage into the Sacramento River or its tributaries until fields were drained for harvest. All water on fields treated with thiobencarb had to be retained on the treated acreage for at least 6 days following application.

2. All water treated with products containing thiobencarb south of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County had to be retained on the treated fields for at least 6 days following application.

Valent Chemical Company, distributor of the granular formulation of thiobencarb (Bolero 10G), agreed to limit distribution of Bolero 10G for use on properties described in 1. above to 4.4 million pounds or enough to treat 110,000 acres. Sales of Abolish 8E, the liquid formulation of thiobencarb marketed by United Agri Products, were limited 15,000 gallons, or enough to treat 30,000 acres.

Carbofuran

The 1993 carbofuran program was designed to maintain carbofuran discharges at low levels and to help assure compliance with the 1993 goal of 0.4 ppb in Central Valley surface waters. The program was implemented using restricted material permits that were conditioned to mitigate water quality problems associated with use. Provisions of this program included:

1. Pre-flood applications of carbofuran to rice fields had to be incorporated into the soil.

2. Water could not be discharged from fields treated with carbofuran for at least 28 days following initial flooding (pre-flood application) or following application (post-plant application) unless the treated water was contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system could be discharged 28 days following the last application of carbofuran within the system.

    a. If the system was under the control of one permittee, treated water could be discharged from the application site in a manner consistent with product labeling.

    b. If the system was under the control of more than one permittee, treated water could be discharged from the application site 9 days following application.

3. The county agricultural commissioner could authorize the emergency release of tailwater 7 days following application following a review of a written request (Appendix 1) which clearly demonstrated that the crop was suffering because of the water management requirements. Additionally, the requester was required to describe preventative action that would obviate the need for future emergency releases. Under an emergency release variance, tailwater could be released only to the extent necessary to mitigate the documented problem. Those issued an emergency release must submit to the county agricultural commissioner a report (Appendix 2) indicating the time and duration of the emergency release and data that could be used to calculate the total amount of water released during the emergency release. Only one emergency release can be granted in each three-year period unless the reason for the emergency release is excessive rainfall, high winds, or other extreme condition that cannot be moderated with management practices.

Methyl parathion

The 1993 methyl parathion program was the same as the 1992 program. It was designed to maintain methyl parathion discharges at low levels and to help assure compliance with the 1993 performance goal of 0.13 ppb in Central Valley surface waters. The program was implemented using restricted material permits that were conditioned to mitigate water quality problems associated with use. The conditions included:

1. Water could not be discharged from fields treated with methyl parathion for at least 24 days following application unless the treated water was contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system could be discharged 25 days following the last application of methyl parathion within the system. Treated water could be discharged from the application site in a manner consistent with product labeling.

2. The county agricultural commissioner could authorize the emergency release of tailwater 7 days following application following a review of a written request (Appendix 1) which clearly demonstrated that the crop was suffering because of the water management requirements. Additionally, the requester was required to describe preventative action that would obviate the need for future emergency releases. Under an emergency release variance, tailwater could be released only to the extent necessary to mitigate the documented problem. Those issued an emergency release must submit to the county agricultural commissioner a report (Appendix 2) indicating the time and duration of the emergency release and data that could be used to calculate the total amount of water released during the emergency release. Only one emergency release can be granted in each three-year period unless the reason for the emergency release is excessive rainfall, high winds, or other extreme condition that cannot be moderated with management practices.

Malathion

The 1993 malathion program was designed to help meet water quality objectives and the 1993 performance goal of 0.1 ppb malathion in Sacramento Valley surface waters. It consisted of a single practice: water should be held on the site of application for at least 4 days following application. The program was voluntary because malathion users were not required to obtain restricted material permits and product labeling did not include such water management requirements. Information addressing this voluntary program (Appendix 3) was provided to rice growers by county agricultural commissioners.

Seepage Control

Users of rice pesticides were required to prevent seepage of field water through the field's weir box, generally by securing the box with plastic and soil.

Drift Control Provisions

In 1992 DPR added drift control provisions to its rice pesticide programs to prevent deposition of rice pesticides to waterways during aerial applications. Applications of methyl parathion, which is formulated as a liquid, had to conform to the drift control regulations specified in Section 6460 in Title 3 of the California Code of Regulations (Appendix 4) as a condition of pesticide use permits. These regulations outline equipment specifications and operations which reduce drift. In addition, the working boom length on fixed wing aircraft could not exceed 3/4 of the wing span and the working boom length on helicopters could not exceed 6/7 of the total rotor length or 3/4 of the total rotor length where the rotor length exceeds forty feet. In 1993, these provisions also applied to applications of Abolish 8E. Also in 1993, no methyl parathion could be applied within 100 feet of the downwind margin of rice fields that were adjacent to waterways. Granular pesticides (i.e. molinate, thiobencarb, and carbofuran) were to be applied in ways that prevent deposition on levees or roads adjacent to waterways. As an additional drift control measure, no rice pesticide could be applied if wind speeds exceeded seven miles per hour.

DISCUSSION

The California Department of Pesticide Regulation (DPR) implemented the programs through county agricultural commissioners. Restricted material permits issued for the use of molinate, thiobencarb, carbofuran, and methyl parathion included conditions with the requirements presented above. When permits were issued, a handout (Appendix 4) explaining the voluntary malathion program was provided. Compliance with permit conditions was enforced by the commissioners.

Molinate

The molinate program retained the water holding requirements that were in place in 1992. Treated water could be recirculated, discharged to fallow fields, or otherwise contained as long as it was not discharged from the system until the 29th day following the last application of molinate to water in the system. If the water in the system was under the control of one permit holder (e.g. contained in a single-grower recirculating system), treated

water could be released from the site of application after label requirements (water held 4 days or until weeds were killed) were met. This allowed individual rice growers to manage water on their property with the maximum flexibility. In multi-grower systems which contain discharges from more than one permit holder (e.g. Reclamation District 108), individual permit holders could not discharge treated water into the system until the 9th day following application. The additional dissipation of molinate on the site of application provided by the additional holding requirement helped protect aquatic resources in the public waterways that are presumably part of these multi-grower systems.

The molinate program also included a provision which allowed molinate users to discharge treated water on an emergency basis before the end of the 28 day post-application holding period with the approval of the county agricultural commissioner. Such releases could occur as early as seven days following application. Written requests were required and had to be submitted on the form provided in Appendix 1 and include an inspection report written by a licensed pest control advisor, which demonstrated that the rice crop was threatened by problems aggravated by the long holding requirement. Only enough water could be discharged to ameliorate the problem. A follow-up report (Appendix 2) was required which indicated the time and duration of the emergency release and included information needed to calculate the total amount of water released during the emergency release.

Thiobencarb

The thiobencarb program also retained the basic structure of earlier programs. The same program, implemented in 1991 and 1992, resulted in no detectable thiobencarb in the Sacramento River.

Carbofuran

The carbofuran program retained the basic strategies of the program used in 1992. For most fields, where carbofuran was incorporated into soil prior to flooding, permit conditions prohibited the discharge of water from fields to state waters for 28 days following flooding. In fields that were treated after field water was drained, the holding time began with the application. For most fields treated with carbofuran, the 28-day holding times were long enough to overlap with the holding times that follow molinate and thiobencarb applications. Thus, the program provided a carbofuran dissipation period of over a month in most cases.

As was the case in the molinate program, water from treated fields could be recirculated, discharged to fallow fields, or otherwise contained as long as it was not discharged from the system until the 29th day following the last application of carbofuran in the system. Provisions for releasing water from the treatment sites in single- and multi-grower systems were as they were described for molinate users. In addition, an emergency release provision, similar to that available to molinate users, was available to carbofuran users.

Methyl parathion

The basic methyl parathion program was as it was since 1991; field water treated with methyl parathion had to be held on the site of application or within approved water management systems until the 25th day following application. An emergency release provision, similar to that available to molinate users, was available to methyl parathion users.

Malathion

As was the case since 1991, the program to reduce discharges of malathion to surface waterways was voluntary since malathion is not a restricted material and use is not subject to use requirements or permit conditions. Information was provided to rice growers explaining the program when they obtained restricted material permits for other rice pesticides.

USE OF SELECTED PESTICIDES IN 1993

In the rice-growing counties in the Sacramento Valley, county agricultural commissioners record the acreage treated with molinate, thiobencarb, carbofuran, and methyl parathion when Notices-of-Application (NOAs) are submitted to each county office. Based on these records, and on pesticide use reports where available, it was estimated that 364,698 acres were treated with molinate, 62,491 with thiobencarb, 164,853 with carbofuran, and 56,192 with methyl parathion (Table 1). These estimates indicate that molinate use increased approximately 3% over the use in 1992, thiobencarb use increased 38%, carbofuran use increased 28%, and methyl parathion use decreased 14%. Pesticide use report data for other important rice pesticides, malathion and bensulfuron methyl (Londax®), are not available yet. Assuming that use patterns of malathion and bensulfuron methyl reflect those in the last years in which use was known and use increased proportionately to increased rice acreage, approximately 5,300 acres were treated with malathion in 1993 and 398,000 with bensulfuron methyl. About 415,000 acres of rice were grown in the Sacramento Valley in 1993, an increase of about 12% over 1992's crop.

COUNTY AGRICULTURAL COMMISSIONERS AND ENFORCEMENT ACTIVITIES

The county agricultural commissioners are responsible for the enforcement of the rice pesticide programs. The role of the commissioners and their staffs include explaining the program to growers, pest control advisers and operators; issuing restricted material permits; inspecting fields for compliance; approving emergency release variances; and providing DPR with information on the use of pesticides.

Before any material on the list of California restricted materials may be applied, growers must obtain a permit from their county agricultural commissioner. The permits may specify conditions for use of the material, including post-application water holding requirements. A Notice-of-Intent (NOI) must be filed with the county agricultural commissioner 24 hours prior to the application, providing the commissioners with the option

to observe the mixing, loading, and application of the material, thus enforcing regulations that pertain to pest control operations. Molinate, thiobencarb, carbofuran, and methyl parathion are currently California restricted materials; malathion is not. Permits which specify post-application water holding requirements, like those for the use of molinate, thiobencarb, carbofuran, and methyl parathion also require that the NOA be filed within 24 hours after the application. Staff of county agricultural commissioners and of DPR made 2,193 inspections of Sacramento Valley rice fields for compliance with water holding requirements; 19 violations were noted.

County agricultural commissioners could grant variances on the holding requirements for fields treated with molinate, carbofuran, and methyl parathion if the length of the holding time was adversely affecting the rice plants. Those granted such variances were instructed to drain water only to the extent necessary to restore a healthy growing environment for the rice seedlings. In 1993, field water was discharged from approximately 10,350 acres under such variances, representing about 2.5% of the total rice acreage in the Sacramento Valley. In 1992, 1,029 acres or about 0.3% of the rice acreage, discharged early under the emergency release provisions (Table 2).

COOPERATIVE WATER QUALITY MONITORING PROGRAM

Summaries of the monitoring activities addressing molinate, thiobencarb, bensulfuron methyl, carbofuran, methyl parathion, and malathion in Sacramento Valley waterways in 1993 are presented below. Locations of monitoring sites referenced in this report are presented in Figure 1. Their abbreviations can be interpreted as follows:

CBD1	Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County, near its outfall on the Sacramento River.
CBD5	Colusa Basin Drain near Highway 20 in Colusa County.
BS1	Butte Slough at Highway 20 in Sutter County.
SS1	Sacramento Slough at the Department of Water Resources gauge station in Sutter County, near its outfall on the Sacramento River.
SR1	Sacramento River approximately 1.5 km upstream from the confluence with American River, in Sacramento County.
SRRAW	Sacramento River at the intake to the water treatment facility in Sacramento, approximately 0.3 km downstream from confluence with American River, in Sacramento County.

Molinate and thiobencarb - The molinate and thiobencarb monitoring program in the Sacramento Valley lasted from early May until mid-July. Semi-weekly samples were collected from the agricultural drains and the Sacramento River from mid-May through June, by the Department of Fish and Game (DFG). During other parts of the monitoring period, samples were collected only once a week. Samples were delivered to Zeneca Ag Products, manufacturer of Ordram, for molinate analyses. Morse Laboratories of Sacramento performed thiobencarb analyses under contract with Valent, primary distributor of products containing thiobencarb. Split samples representing about 20% of the total

collected were analyzed by the DFG laboratory for the presence of both compounds for quality assurance.

The City of Sacramento analyzed water samples collected from the Sacramento River at the intake to its water treatment plant from May 11 through June 23. Samples were collected and analyzed about three times a week.

Bensulfuron methyl - The DFG collected water samples from the Colusa Basin Drain at CBD1 and Sacramento Slough at SS1 twice each week from May 20 through June 17. After reviewing pesticide use patterns, 8 of the 16 samples were selected on the basis that they would contain the highest bensulfuron methyl concentrations. Bensulfuron methyl has yet to be detected in surface waters at concentrations that are of concern. The samples were analyzed by Morse Laboratories in Sacramento under contract with E. I. du Pont de Nemours and Company, manufacturer of Londax.

Carbofuran - Samples were collected by DFG from the Colusa Basin Drain at CBD1 and CBD5, Butte Slough at BS1, Sacramento Slough at SS1, and the Sacramento River at SR1 twice weekly from April 20 through July 15. However, during the April and July sampling periods, BS1, CBD1, and SR1 were sampled only once each week. Analyses were performed by FMC Corporation, who markets Furadan. About 20% of the samples were split with DFG, whose laboratory analyzed the samples for quality assurance.

Methyl parathion and malathion - Samples were collected by DFG from the Colusa Basin Drain at CBD1 and CBD5, Sacramento Slough at SS1, and the Sacramento River SR1 weekly from May 3 through June 15; twice weekly from May 13 through July 1. Analyses were performed by DFG. About 25% of the samples were split with the California Department of Food and Agriculture (CDFA) laboratory, who analyzed the samples for quality assurance under contract with DPR.

Quality assurance program - In order to insure that the results of this cooperative monitoring program are accurate and credible, quality assurance/quality control provisions were included in the 1993 monitoring program for molinate, thiobencarb, carbofuran, methyl parathion, and malathion. These provisions included:

1. Colusa Basin Drain water, collected before the rice pesticide use season, was split and provided to each of the participating laboratories to use as the matrix in internal quality control procedures (i.e. spike-recovery). This water was also used by the CDFA laboratory when it spiked water for use in other spike-recovery exercises.

2. Participating laboratories were required to demonstrate their ability to analyze the pesticides at an appropriate level of detection. CDFA prepared and distributed spiked samples to be used for this purpose.

3. Each laboratory's spike-recovery data were compared to the lab's performance control limits for the analytical method.

4. No less than 20% of the field samples were split and analyzed by another laboratory.

5. Colusa Basin Drain water was spiked by the CDFA laboratory and included in sets of field samples as blind spikes.

6. Every field sample was split and stored as backup samples in the event that samples were broken or if analytical results needed verification.

RESULTS OF THE 1993 MONITORING PROGRAM

Molinate - Concentrations of molinate in samples collected from agricultural drains and the Sacramento River are presented in Table 3. The Zeneca laboratory reported that the highest concentration of molinate detected in these waterways in 1993 was the 96.1 ppb in the Colusa Basin Drain (CBD5) on June 14. These data indicate that the performance goal for molinate (10 ppb) was exceeded at each monitoring site except in the Sacramento River.

The highest concentration of molinate detected in the Sacramento River was 1.7 ppb in a sample collected by the City of Sacramento at the intake to its water treatment facility on June 14 (Table 5). A peak of 0.29 ppb was found there in 1992.

Thiobencarb - Analytical results reported by Morse Laboratories indicated that thiobencarb concentrations in the agricultural drains were highest in the Colusa Basin Drain (CBD1) where they peaked at 4.87 ppb on June 17 (Table 6). Based on these results, the thiobencarb performance goal (1.5 ppb) was exceeded at both sites on the Colusa Basin Drain, but not at the sites on other agricultural drains or in the Sacramento River. Table 7 presents the peak concentrations of thiobencarb in Sacramento Valley waterways in each year since 1981. The City of Sacramento also did not detect thiobencarb in the Sacramento River (Table 6).

Bensulfuron methyl - Concentrations of bensulfuron methyl detected at CBD1 and SS1 are presented in Table 8. The highest concentration was 1.82 ppb, detected in a sample collected at CBD1 on June 7.

Carbofuran - Results of carbofuran analyses performed by FMC and DFG are presented in Table 9. The performance goal for carbofuran was exceeded in the Colusa Basin Drain at CBD1 and CBD5 and in Butte Slough, where peak concentrations of 3.0, 0.8, and 0.8 ppb were detected, respectively. In 1992 the highest carbofuran concentrations detected in the Sacramento Valley was 0.6 ppb, detected in the Colusa Basin Drain at CBD5. Carbofuran was not detected in the Sacramento River in 1993.

Methyl parathion - Results of methyl parathion analyses performed by the DFG and CDFA laboratories indicated that the methyl parathion performance goal was exceeded in the Colusa Basin Drain (Table 10). The highest concentration reported by DFG in this

survey was 1.1 ppb, detected samples collected from CBD5 on May 10. The CDFA laboratory detected up to 1.40 ppb in these samples. The peak methyl parathion concentration in 1992, 0.3 ppb, was detected in a sample collected from Sacramento Slough.

Malathion - Analytical results indicated that the malathion performance goal was exceeded in the Colusa Basin Drain (CBD5) on May 31 (Table 11). In 1992, malathion was detected only once during the survey, at a concentration (0.1 ppb) that was apparently in compliance with the performance goal.

Quality assurance program - After reviewing the results of this program, it appears that the results of the primary laboratories are valid. The only notable discrepancies occurred in the results from the carbofuran analyses performed on split field samples by the FMC and DFG laboratories (Table 9). The results of the two laboratories did not agree well when carbofuran concentrations were very low, illustrated the difficulty sometimes in confirming pesticide concentrations when the concentrations are near the limit of detection.

MASS TRANSPORT IN THE SACRAMENTO RIVER

Estimates of the total mass of molinate and thiobencarb transported in the Sacramento River past Sacramento may be used to compare the pesticide load in the river in different years. However, mass transport cannot be used to determine compliance with performance goals. The estimated mass transport of molinate and thiobencarb in the Sacramento River past Sacramento during 1982 through 1993 is presented in Table 12. The mass transport of molinate in 1993 was estimated to be 4,232.4 lbs (2006.9 kg) , a dramatic increase from the 1992 estimate (124 lbs). Molinate loading could have been significantly higher had flows in the Sacramento River been more typical and low enough for the Colusa Basin Drain, the most important source of rice pesticides for the Sacramento River, to flow into the river. Instead, Colusa Basin Drain flows were diverted for much of the monitoring period into the Yolo Bypass around the monitoring site at Sacramento. This condition occurred in 1982, also under conditions of high river flows. Nevertheless, molinate loading in the Sacramento River at Sacramento was the greatest since 1988. Since thiobencarb was not detected in the Sacramento River in 1993, mass transport is assumed to have been zero.

WEATHER AND ITS INFLUENCE ON WATER QUALITY

Weather conditions, especially those during and after applications of rice pesticides influence the performance of water quality control programs. Dissipation rates of many pesticides, e.g. molinate, increase with increasing temperature, so warm weather during water holding periods helps reduce concentrations once post-application discharges resume. Warm weather in May of 1987 and 1992 helped explain why concentrations in waterways and mass transport in the Sacramento River were relatively low in those years. Conversely, May 1990 was cool and rainy and the results of the molinate program were

not as successful. Thus, it is important to be aware of weather patterns when reviewing monitoring data.

In 1993, cool rainy weather prevailed in late May and early June in the rice-growing region. Rainfall during this period is in itself unusual, but in 1993 the rainfall was also unusually intense. In Colusa, daily rainfall records (42-year record) were set on six dates (Figure 2). In addition, daytime high temperatures were well below average (Figure 3). The rainy weather occurred during the time when most fields were under the water management restrictions that follow early season pesticide applications. It also occurred when the rice plants were in their earliest growth stages, when it is important for the plants to emerge quickly through the field water and establish strong root systems.

Many growers, experiencing uncontrollable, deep water in their rice fields during and after the rainy period, applied for emergency release variances with their county agricultural commissioners. In 1993, 178 emergency releases were granted; 92% of those were for reasons associated with deep water and cool temperatures (Figure 4). There is no indication that the emergency releases were granted to anyone except those with genuine hardship. Almost all of the growers who used emergency releases had laser-leveled fields and several had static or recirculating systems; systems that in most circumstances give growers better control of field water than conventional water management systems. If the growers who received emergency releases had been required to retain the excess water on the 10,350 affected acres, significant economic loss would have resulted. If the assumptions provided by the California Rice Industry Association in their 1992 report "Rice Pesticide Emergency Release Report" are applied, an estimated $11.7 million dollar loss would have occurred in 1993. In 1992, only 26 emergency releases were granted.

Large drainage districts that normally recapture and reuse all tailwater during this period had to discharge water from the systems prior to the time specified in DPR's program. Retaining all water within the districts during the rainy period would have resulted in flooding of property. Presumably, additional economic loss would have occurred if these districts retained drainage water.

It is difficult to assess the contribution that emergency releases may have had on the pesticide loading in Sacramento Valley waterways. However, the qualitative significance of emergency releases can be estimated by comparing estimates of molinate loading in the Colusa Basin Drain at CBD5 and molinate discharges in the Drain's watershed during emergency releases. These discharge estimates can be calculated using the information submitted by those granted emergency releases (Appendices 1 and 2). However, it is important to note the assumptions used in this comparison. For example, the dissipation rates of molinate in each field under the conditions preceding the emergency releases are not known. It is assumed that molinate dissipated from field water after a peak concentration of 3 parts per million on the day following the application with a half-life of four days . No account was made of potential dilution effects that the rain may have provided in rice fields treated with molinate. Information submitted by those granted emergency releases (i.e. completed forms presented in Appendices 1 and 2), is assumed to be accu-

rate. In addition, while molinate continues to dissipate as it is transported in drain water from the fields' discharge points to the monitoring site at CBD5, such dissipation cannot be quantified. For the purposes of this exercise, dissipation of molinate as it is transported in agricultural drain water is assumed to be zero. Such comparisons suggest that discharges from fields where field water was lowered during emergency releases were important, perhaps the most significant, contributors of molinate in the Colusa Basin Drain in early June. The estimated daily mass discharge of molinate from fields during emergency release increased on June 1, peaked on June 3, then quickly declined after June 6. The peak daily discharge was more than twice the peak daily mass transport of molinate at CBD5, which occurred on June 6. Therefore, even after a cautious review of this information, it appears that emergency releases contributed significantly to the molinate loading in the Colusa Basin Drain.

During the 1993 season, Regional Board staff investigated acute toxicity in receiving waters associated with emergency releases (Schnagl and Wyels 1994). Water samples were collected from tailwater flowing from fields undergoing emergency releases and fields which had completed their required holding times. These water samples were used to conduct 96-hour static renewal bioassays using the invertebrate *Ceriodaphnia* sp. Water from fields which had completed their holding times were not toxic. Nine of ten samples collected from fields undergoing emergency releases were acutely toxic to this test organism.

These data suggest that when water is discharged from treated rice fields after relatively short holding periods, the discharged water may be acutely toxic and that this situation may not be limited to emergency releases. Specifically, the 1993 program allowed field water to be released into certain drainages and water management systems after only nominal water holding requirements. These systems included drainage districts that normally recapture and reuse all tailwater during the pesticide use and discharge period. It is reasonable to assume that field water released under these conditions is acutely toxic as well and violate the water quality objective for toxicity.

SOURCES OF PESTICIDES IN 1993

Pesticides used in rice culture may enter surface water from five sources under normal conditions. Drift during aerial applications and transport through levees with seepage water can be expected to contribute to loading during and shortly after the application period. Discharges from fields prior to the end of the legal holding times (i.e. illegal releases and emergency releases), are most prevalent two to four weeks following application. Legal releases are the predominant source of loading after the water holding requirements lapse. By examining the occurrence of each rice pesticide in surface water in relation to its application schedule, presumptions can be made regarding the effects of each potential source.

Molinate concentrations in the Colusa Basin Drain rose during the application period to levels that exceeded the performance goal (Figure 5), indicating that aerial drift, seepage,

or both may be important sources of contamination. Concentrations rose sharply in early June after the rainy period. As suggested above, emergency releases that followed the unusual weather may have been the most significant source of molinate in early June. After the influence of emergency releases declined in mid-June, other sources, perhaps legal releases following the holding period, became important. However, Drain flows dropped so quickly after the rains stopped (from almost 1,000 cubic feet per second [cfs] at CBD5 on June 6 to under 100 cfs on June 14) that the mass of the molinate transported to the lower Colusa Basin Drain was relatively small. In late June and July, the most important molinate sources were undoubtedly legal releases. In 1991 and 1992, years without the confounding influences of unusual weather and high numbers of emergency releases, it was concluded that the early season sources, namely aerial drift and seepage, were the most important contributors of molinate to the Colusa Basin Drain.

In Butte Slough, molinate concentrations exceeded the performance goal only during and shortly after the rainy period (Figure 6). However, the nature of the molinate sources are even more ambiguous than those contributing to Colusa Basin Drain contamination. Only ten emergency releases were granted in Butte County and cannot account for the magnitude and duration of the contamination in Butte Slough; neither can illegal discharges. Perhaps RD 1004, a drainage district that normally recaptures tailwater and recirculates it, contributed significant molinate when it discharged into Butte Creek during the rainy period before the time allowed in DPR's program. In addition, almost all of the legal releases from molinate-treated fields occurred after June 15, when concentrations in Butte Slough were below the performance goal. The only conclusion that can be drawn is that the high concentrations appear to be associated with the unusual weather.

The sources of thiobencarb that entered surface water in 1993 are not well understood either. Clearly the peak concentrations occurred near the end of the rainy period, a time when emergency releases or illegal releases might be expected to be potential sources. However, only two emergency releases were granted to growers in the Colusa Basin (118 acres on June 2 and 75 acres on June 7). It is unlikely that these fields had more than a trivial impact on the thiobencarb concentrations downstream. In addition, aerial drift and seepage were apparently not significant and the highest concentrations occurred too early to have originated in fields where water was held for the full thirty-day holding requirement (Figure 7). As was the case with molinate concentrations in Butte Slough, there are no strong associations with thiobencarb concentrations and causative factors aside from unusual weather.

Carbofuran concentrations in Butte Slough (Figure 8) and the Colusa Basin Drain (Figure 9) peaked while applications were heavy within their respective drainages. This situation is similar to those seen with carbofuran in recent years. It suggests that aerial drift, seepage, or both were the sources of carbofuran. In Butte Slough, concentrations declined to levels in compliance with performance goals by the time the earliest legal releases occurred in early June. However, sources of the carbofuran that occurred in the Colusa Basin Drain from late May through mid-June are ambiguous because they could have included drift, seepage, emergency releases, legal releases, or a combination. Per-

haps unknown factors associated with the cool, rainy weather also affected the amount of carbofuran discharged into the Drain.

Methyl parathion concentrations were highest in the Colusa Basin Drain at CBD5 during the application period (Figure 10); aerial drift is the most probable source. Until the rainy period, that was the only site where methyl parathion was detected. Then methyl parathion was detected briefly at each of the other monitoring sites as well. Emergency releases may have been a source, although very few of those granted emergency releases used methyl parathion.

The sources of malathion are difficult to determine, especially since pesticide use report data for malathion are not available yet. However, the monitoring data suggest detections in Sacramento Slough were probably due to aerial drift and detections in the Colusa Basin Drain in late May and June were associated with the unusual weather. Emergency releases probably did not play a role; only one grower granted an emergency release reported using malathion and the treatment was made twelve days prior to the release.

In summary, it was apparent that the sources that were important in 1992, i.e. the early season sources like aerial drift and seepage, continued to contribute significantly in 1993 to the concentrations of rice pesticides found in surface waterways. However, unseasonable rains were an important factor in increasing pesticide concentrations and loading; in the case of molinate and thiobencarb, rainfall was *the* most important factor.

1994 PROGRAM

PROGRAM DESCRIPTIONS

In 1994, rice pesticide programs will continue to use restricted material permits and associated conditions to implement the water management requirements that reduce pesticide discharges into surface waters. In addition, management of other important sources of contamination will continue to improve. Thus, these programs will protect performance goals under a wider variety of conditions than earlier programs. They will also help assure compliance with the water quality objective for toxicity.

Molinate

I. All water treated with products containing molinate must be retained on the site of application for at least 28 days following application unless

   A. the treated water is contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 29 days following the last application of molinate within the system.

1. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

2. If the system includes drainage from more than one permittee,

   a. but is not considered a public water system, treated water may be discharged from the application site into the system 9 days following application.

   b. and is considered a public water system, treated water may be discharged from the application site into the public system 12 days following application.

B. the treated water is on acreage within the bounds of specific geographic areas that discharge negligible amounts of rice field drainage into the Sacramento River or its tributaries until fields are drained for harvest. All water on fields treated with molinate must be retained on the treated acreage until the 12th day following application.

II. Fields not specified in I.A. may resume discharging field water 29 days following application at a volume not to exceed two inches of water over a drain box weir. Unregulated discharges from these fields may then resume after 7 days.

III. The county agricultural commissioner may authorize the emergency release of tailwater 12 days following the last molinate application, following a review of a written request (Appendix 1) which clearly demonstrates the crop is suffering because of the water management requirements. All water management requirements must be followed that are associated with other pesticides that may have been applied to the site. Additionally, the requester must describe preventative action that would avoid the need for future emergency releases. Under an emergency release variance, tailwater may be released only to the extent necessary to mitigate the documented problem. Those issued an emergency release must submit to the county agricultural commissioner a report (Appendix 2) indicating the time and duration of the emergency release and data that can be used to calculate the total amount of water released during the emergency release. Emergency release will only be granted for reasons related to rainfall, high winds, or other extreme weather conditions that cannot be moderated with management practices.

Thiobencarb

I. Sacramento Valley (north of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County), all use except Abolish 8EC applied using the "preflood surface" method.

A. All water on treated fields must be retained on the treated fields for at least 30 days following application unless the water is contained within a tailwater recovery

system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 20 days following the last application of thiobencarb within the system.

1. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

2. If the system includes drainage from more than one permittee,

   a. but is not considered a public water system, treated water may be discharged from the application site into the system 7 days following application.

   b. and is considered a public water system, treated water may be discharged from the application site into the public system 20 days following application.

B. Fields not specified in I.A.1. and I.A.2. may resume discharging field water 31 days following application at a volume not to exceed two inches of water over a drain box weir. Unregulated discharges from these fields may then resume after 7 days.

II. Southern Area (south of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County), all use except Abolish 8EC applied using the "preflood surface" method.

A. All water on treated fields must be retained on the treated fields for at least 19 days following application unless the water is contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 20 days following the last application of thiobencarb within the system.

1. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

2. If the system includes drainage from more than one permittee,

   a. but is not considered a public water system, treated water may be discharged from the application site into the system 7 days following application.

   b. and is considered a public water system, treated water may be discharged from the application site into the public system 20 days following application.

B. Fields not specified in II.A.1. and II.A.2. may resume discharging field water 20 days following application at a volume not to exceed two inches of water over a drain box weir. Unregulated discharges from these fields may then resume after 7 days.

III. All areas, fields treated with Abolish 8EC using the "preflood surface" method.

A. All water on treated fields must be retained on the treated fields for at least 19 days following application unless the water is contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 20 days following the last application within the system.

1. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

2. If the system includes drainage from more than one permittee, treated water may be discharged from the application site into the system 7 days following application.

B. Fields not specified in III.A. and III.B. may resume discharging field water 20 days following application at a volume not to exceed two inches of water over a drain box weir. Unregulated discharges from these fields may then resume after 7 days.

Carbofuran

I. Pre-flood applications of carbofuran to rice fields must be incorporated into the soil.

II. Water shall not be discharged from sites treated with carbofuran for at least 28 days following initial flooding (pre-flood application) or following application (post-plant application) unless the treated water is contained within tailwater recovery systems, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 29 days following the last application of carbofuran within the system.

A. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

B. If the system includes drainage from more than one permittee but is not considered a public water system, treated water may be discharged from the application site into the system 9 days following application.

III. Discharges into public water systems do not qualify for holding requirements shorter than 28 days.

Methyl parathion

I. Water shall not be discharged from sites treated with methyl parathion for at least 24 days following application unless the treated water is contained within tailwater

recovery systems, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 25 days following the last application of methyl parathion within the system.

A. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

B. If the system includes drainage from more than one permittee but is not considered a public water system, treated water may be discharged from the application site into the system 9 days following application.

II. Discharges into public water systems do not qualify for holding requirements shorter than 24 days.

Malathion

The 1994 malathion program will be the same as the 1993 program. It is designed to maintain malathion discharges at low levels and help, along with efforts to minimize spray drift, to assure compliance with the 1994 performance goal of 0.1 ppb in Central Valley surface waters. The program will consist of a single practice: water should be held on the site of application for at least 4 days following application. Information addressing this voluntary program will be provided to rice growers by county agricultural commissioners.

DISCUSSION

Water holding requirements - Significant changes in water holding requirements are proposed for users of rice pesticides within public water systems that qualified as approved multi-grower systems. In order to prevent what the Regional Board determined to be acutely toxic discharges of pesticides into these systems, water holding times have been increased, except for those affecting fields treated with Abolish 8EC applied using the preflood surface method. Lengthening the water holding times will provide the additional dissipation needed to prevent acutely toxic discharges. However, water holding times will not be increased in multi-grower systems that are not considered public water systems. These systems will be evaluated to determine which, if any, have public waterways that may receive discharges that are potentially acutely toxic. Then holding times within these systems may be adjusted as necessary to prevent such discharges.

The water holding times will remain as they were in 1993 for fields in multi-grower systems that are treated with thiobencarb as Abolish 8EC using the preflood surface method. In addition, fields with conventional water management practices that are treated with thiobencarb in this manner will have a shorter holding time in 1994 (19 instead of 30 days). This is in recognition of the favorable dissipation characteristics of thiobencarb applied as Abolish 8EC and of its significantly lower discharge potential

compared to thiobencarb applied as Bolero 10G (Valent 1993). The estimated concentration of thiobencarb in water discharged from an Abolish-treated field after a 19-day hold is about 6 ppb; from a Bolero-treated field after a 30-day hold is about 38 ppb. The lower holding time for Abolish 8EC may attract thiobencarb users who would have otherwise used Bolero 10G, thereby decreasing the overall thiobencarb loading in Sacramento Valley waterways.

Drift Control - Additional equipment and operational requirements will make requirements for aerial applications of methyl parathion even more restrictive than the requirements in 1993. The DPR is currently discussing options with the California Agricultural Aircraft Association and will update the Regional Board at its meeting on March 25.

Education: - As was the case in 1993, DPR staff will use training opportunities to educate applicators on the importance of keeping applications of all rice pesticides on the target field and on the penalties for violations. Staff will also use opportunities to present information directly to growers on the importance of water management on reducing pesticide discharges to surface waters. In addition, staff of county agricultural commissioners will be provided with training on water quality issues so they can adequately convey the concerns of state agencies when growers apply for pesticide use permits.

Seepage - In 1993, no additional investigations addressed seepage. In 1994, staff of the county agricultural commissioners will note, during regular inspections for water holding compliance, where water is seeping out of the confines of rice fields. These sites can be visited so that water samples can be collected and analyzed. Of particular interest are the small ditches that sometimes channel seepage water to agricultural drains. It is important to have a better understanding of the distribution of such ditches and their contents as they discharge into surface waterways.

Emergency releases - The proposed provisions recognize that sufficient time must be provided for pesticides to dissipate prior to discharge, or the pesticides will remain at acutely toxic concentrations. The dissipation characteristics of molinate (Scardaci et al. 1987), carbofuran (Nicosia et al. 1990) and methyl parathion (Kollman et al. 1992) were reviewed and compared to toxicity values reported in Harrington (1990), Menconi and Gray (1992), and Menconi and Harrington (1992), respectively. Molinate should dissipate to concentrations that are not acutely toxic to the most sensitive test organisms after about 11 days. Carbofuran and methyl parathion concentrations apparently would not reach nontoxic levels before the end of the basic water holding requirements of 28 and 24 days, respectively. Thus, emergency releases cannot occur from fields treated with molinate until the 12th day following application. Emergency releases will only be granted for reasons related to rainfall, high winds, or other extreme weather conditions that cannot be moderated with management practices. Staff of the county agricultural commissioner or approved state personnel must inspect the site before an emergency release can be granted. The reporting requirements remain as they were in 1993. The emergency release provisions have been eliminated from the carbofuran and methyl parathion programs.

Enforcement - County agricultural commissioners will take additional steps in 1994 to make water quality programs for rice pesticides more enforceable. These steps include:

- Requiring growers to block drainage structures with soil during the water holding periods. Soil barriers will be disturbed in the event of illegal releases, making it easier for county commissioners' staff to identify violators of the water holding requirements.

- Sanctions on repeat and multiple violators of water management requirements. Issuance of pesticide use permits to such violators will require the violator to follow special permit conditions that will assure compliance.

These measures will help make violations easier to monitor and will provide for more stringent penalities for violators. The measures will provide more assurance that water management requirements are followed. It is important that concern over illegal releases be allayed so that the impacts of other sources of rice pesticides can be more accurately considered.

Beginning in 1994, repeat and multiple violators will be required, as part of special permits conditions, to make improvements in their water management capabilities. Such improvements may include installation of pumps for tailwater recirculation or leaving land fallow to contain spillage.

Growers who violate water holding requirements are subject to maximum penalties. However, conditions preceding violations (e.g. unfavorable field conditions that could not be moderated by the growers' best efforts) may be considered when assessing penalties.

Thiobencarb use - In 1994, the limitations on the sales of thiobencarb products have been removed. Programmatic changes such as the berming of drainage structures, longer holding times in closed public systems, and incentives for increasing the market share of Abolish 8EC should improve water quality overall and preclude the need for a sales limitation. In addition, sales of Bolero and Abolish in 1994 are not expected to exceed those defined by the sales limitation of 1993.

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Table 1. Acres treated with molinate (Ordram®)[1], thiobencarb (Bolero®), carbofuran (Furadan®), and methyl parathion in the counties of the Sacramento Valley in 1993[2].

	Acres treated			
County	molinate	thiobencarb	carbofuran	methyl parathion
Butte	73,427	9,790	57,321	2,526
Colusa	100,495	18,075	41,297	20,351
Glenn	66,293	3,236	20,859	2,427
Placer	11,173	3,556	6.976	4,277
Sacramento	6,434	2,382	1,363	2,611
Sutter	67,205	13,071	16,919	15,266
Tehama	1,120	40	131	72
Yolo	8,905	10,848	428	1,013
Yuba	29,646	1,493	23,421	7,689
Totals	364,698	62,491	168,721	56,192

1. Values higher than estimated rice acreage in 1993 because molinate may be applied more than once at each site.

2. Values are based on Notices-of-Application submitted to county agricultural commissioners.

Table 2. Acres of molinate-treated rice fields where water was discharged under emergency release variances in the Sacramento Valley in 1987 - 1993.

Year	Acres	Percent of total acres treated
1987	5,712	1.94
1988	4,897	1.41
1989	3,235	0.86
1990	23,394	6.32
1991	2,224	0.70
1992	1,029	0.29
1993	10,350	2.50

Table 3. Molinate concentrations in Sacramento Valley waterways[1] in 1993[2].

	Molinate (ppb)				
Date	CBD1	CBD5	SS1	BS1	SR1
5/3	ND[3]	ND (ND)[4] ND[5]	ND	ND	ND
5/10	ND	6.26 (5.7) 6.10	ND	ND	ND[6]
5/13		7.07 (3.3) 6.78[5]			
5/17	ND	3.5 (13) 13.6[5]	ND	ND	ND
5/20	ND	20.2 (18) 21.0	ND ND[5]	ND	ND
5/24	7.82	20.5 (17)	ND ND[5]	5.52	ND
5/27	21.0	23.3 (21)	3.30	23.3	ND
5/31	21.5	30.6 (31)	14.4	17.9	1.8
6/3	48.4 48.3[6] 48.3[5]	6.23 (51) (50)[5] 57.8[6]	17.8	26.3 26.0[5]	ND
6/7	72.7	59.2 (50)	22.7	39.2	ND
6/10	66.7 71.5[5]	57.9 (56)	26.5	37.3	2.59
6/14	51.6	96.1 (92)	31.2	23.3	2.04
6/17	53.6	31.1 (33) 32.9[5]	20.7	13.6	ND
6/21	47.0	21.0 (23)	12.4 13.1	7.73	ND
6/24	39.5	38.5 (36)	10.7	6.58	ND
6/28	33.9 35.5[5]	5.80 (5.3)	6.77	4.38	ND
7/1	23.7	5.53 (4.1)	4.90	4.46	ND
7/8	6.24	2.81 (3.1)	3.66	2.98	ND
7/15	2.80	2.32 (1.9) 2.30[5]	2.31	2.16	ND

1. CBD1 Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County.
   CBD5 Colusa Basin Drain at Highway 20 in Colusa County.
   SS1 Sacramento Slough at DWR gauge station in Sutter County.
   BS1 Butte Slough at Highway 20 in Sutter County.
   SR1 Sacramento River at Village Marina in Sacramento County.

2. Samples collected by the California Department of Fish and Game (CDFG) and analyzed by Zeneca Ag Products.

3. ND None detected, limit of detection = 1.0 ppb.

4. Values in parentheses are results of analyses performed on split samples by the CDFG Water Pollution Control Laboratory, Rancho Cordova. Limit of detection = 0.5 ppb.

5. Duplicate analysis.

6. Result of an analysis of a backup sample.

Table 4. Peak molinate (Ordram®) concentrations in selected Sacramento Valley waterways[1] in 1981 - 1993.

	Concentration (ppb)				
Year	CBD1	CBD5	SS1	BS1	SR1
1981	340	357	[2]		
1982	204	697		187	27
1983	211	228	68		7
1984	110	120	44		21
1985	95	100	49		16
1986	77	88	30		11
1987	43	53	22	44	7.6
1988	67	89	30	52	8.0
1989	51	60	30	43	6.0
1990	51	59	40	36	8.9
1991	18	17	9.6	26	1.3
1992	6.2	24	15	26	ND[3]
1993	69.1[4]	96.1	31.2	39.2	2.59

1. CBD1 Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County.
   CBD5 Colusa Basin Drain at Highway 20 in Colusa County.
   SS1 Sacramento Slough at DWR gauge station in Sutter County.
   BS1 Butte Slough at Highway 20 in Sutter County.
   SR1 Sacramento River at Village Marina in Sacramento County.

2. Blanks indicate that no data are available.

3. ND None detected. Limit of detection = 1.0 ppb.

4. Mean of duplicate analyses.

Table 5. Concentrations of molinate and thiobencarb in the Sacramento River at the intake to the City of Sacramento water treatment facility in 1993[1].

Date	Concentration (ppb) molinate	thiobencarb	Date	Concentration (ppb) molinate	thiobencarb
5/11	ND[2]	ND	6/09	0.45	ND
5/19	ND	ND	6/11	1.5	ND
5/21	ND	ND	6/13	1.1	ND
5/25	ND	ND	6/14	1.7	ND
5/28	0.56	ND	6/16	0.36	ND
5/31	0.74	ND	6/18	0.16	ND
6/02	0.89	ND	6/21	0.10	ND
6/04	0.18	ND	6/23	ND	ND
6/07	0.12	ND			

1. Samples collected and analyzed by the City of Sacramento.

2 ND None detected. Limit of detection = 0.10 ppb.

Table 6. Thiobencarb concentrations in Sacramento Valley waterways[1] in 1993[2].

	Thiobencarb (ppb)					
Date	CBD1	CBD5		SS1	BS1	SR1
5/3	ND[3]	ND ND	(ND)[4]	ND	ND	ND
5/10	ND	ND ND	(ND)	ND	ND	ND
5/13		0.128[5]	(ND)			
5/17	ND	1.06 1.12	(1.0)	ND	ND	ND
5/20	0.320	0.224 0.224	(ND)	ND	ND	ND
5/24	0.288	ND	(ND)	ND	ND	ND
5/27	0.320	0.352	(ND)	ND	ND	ND
5/31	0.480	0.704	(0.7)	0.160	ND	ND
6/3	2.21	3.68	(3.1)	0.128	0.320	ND
6/7	4.87	1.82	(1.0)	0.192	0.416	ND
6/10	1.98	1.25	(0.9)	0.192	0.192	ND
6/14	2.98	1.18	(0.8)	ND	ND	ND
6/17	2.40	0.736	(0.7)	0.096	0.096	ND
6/21	1.18	0.640	(0.7)	0.064	ND	ND
6/24	0.608	0.304	(ND)	0.064	ND	ND
6/28	0.544	1.57	(2.1)	0.064	0.096	ND
7/1	0.256	0.352	(ND)	0.096	0.096	ND
7/8	0.224	0.352	(0.5)	ND	ND	ND
7/15	0.096	0.192	(ND)	0.064	ND	ND

1. CBD1 Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County.
   CBD5 Colusa Basin Drain at Highway 20 in Colusa County.
   SS1 Sacramento Slough at DWR gauge station in Sutter County.
   BS1 Butte Slough at Highway 20 in Sutter County.
   SR1 Sacramento River at Village Marina in Sacramento County.

2. Samples collected by the California Department of Fish and Game (CDFG) and analyzed by Morse Laboratories, Sacramento

3. ND None detected, limit of detection = 0.1 ppb.

Table 7. Peak thiobencarb (Bolero®) concentrations in selected Sacramento Valley waterways[1] in 1981 - 1993.

	Concentration (ppb)				
Year	CBD1	CBD5	SS1	BS1	SR1
1981	21	23	[2]		
1982	57	170		10	6
1983	11.3	9.0	4.9		0.8
1984	7.5	14.0	7.8		1.0
1985	19	18	11		4.1
1986	7.4	6.9	3.8		1.1
1987	3.7	1.5	0.6	ND[3]	ND
1988	4.5	0.6	ND	1.0	ND
1989	1.34	0.55	ND	0.98	ND
1990	ND	ND	ND	2.0	ND
1991	ND	ND	ND	ND	ND
1992	5.7	6.7	2.0	9.7	ND
1993	4.87	3.68	<0.5[4]	<0.5	ND

1. CBD1 Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County.
   CBD5 Colusa Basin Drain at Highway 20 in Colusa County.
   SS1 Sacramento Slough at DWR gauge station in Sutter County.
   BS1 Butte Slough at Highway 20 in Sutter County.
   SR1 Sacramento River at Village Marina in Sacramento County.

2. Blanks indicate that no data are available.

3. ND Not detected. Different detection limits were reported during this period, all of which were less than or equal to 1.0 ppb.

4. Less than limit of quantitation.

Table 9. Carbofuran concentrations in Sacramento Valley waterways[1] in 1993[2].

	Concentration (ppb)				
Date	CBD1	CBD5	SS1	BS1	SR1
4/20		(ND[3])[4]	0.1		
		ND	ND		
			ND		
4/22	0.1	0.1 (ND)	ND	ND	ND
	0.1	ND	ND	ND	ND
4/26		0.2	ND		
		0.2[5]	ND[5]		
4/29	ND	0.3 (0.3)	ND	ND	ND
5/3	ND	0.2 (0.2)	ND	ND	ND
		0.2			
5/6	ND	2.8 (3.3)	ND	ND	ND
		3.0[5]	ND		
5/10	ND	1.0 (0.9)	ND	0.2	ND
		0.9 (0.8)			
5/13	ND	0.3 (0.2)	0.2	0.3	ND
		0.4	ND[5]		
		0.3[5]			
5/17	ND	0.4 (0.2)	0.1	0.7	ND
		0.4[5]	ND[5]	0.4[5]	
		0.4			
		0.3[5]			
5/20	ND	0.4 (0.2)	ND	0.8	ND
5/24	ND	0.3 (ND)	ND	0.5	ND
5/27	0.5	0.9 (0.2)	0.1	0.5	ND
5/31	0.5	1.9 (1.9)	0.3	0.6	ND
6/3	0.7	0.7 (1.1)	ND	0.4	ND
6/7	0.8	1.1 (1.2)	ND	0.4	ND
6/10	0.6	0.5 (1.1)	0.3	0.4	ND
6/14	0.2	0.6 (1.1)	0.3	0.3	ND
6/17	ND	0.3 (0.9)	0.3	0.2	ND
6/21	ND	0.1 (1.0)	0.1	0.2	ND
6/24	ND	0.3 (0.9)	ND	0.2	ND
6/28	ND	0.2 (0.8)	ND	0.3	ND
7/1	ND	0.3 (0.5)	ND	0.3	ND
7/6		0.2	ND		
7/8	ND	0.2 (0.4)	0.1	0.4	ND
7/12		0.2	ND		
7/15	ND	0.2 (0.8)	ND	0.3	ND

Table 10. Methyl parathion concentrations in Sacramento Valley waterways[1] in 1993[2].

	Methyl parathion (ppb)			
Date	CBD1	CBD5	SS1	BS1
5/3	ND[3]	ND (ND)[4]	ND	ND
	ND	ND (ND)	ND	ND
		ND		
5/10	ND	1.1 (1.35)	ND	ND
		1.1 (1.40)		
5/13		0.11 (0.13)		
5/17	ND	0.21 (0.23)	ND	ND
		0.13		
5/20	ND	0.06 (0.08)	ND	ND
		0.07		
5/24	ND	0.14 (0.15)	ND	ND
5/27	ND	ND (0.05)	ND	ND
5/31	0.10	0.22 (0.24)	0.10	ND
6/3	0.09	0.17 (0.19)	0.06	0.11
6/7	0.12	ND (0.12)	0.07	0.07
6/10	ND	ND (ND)	ND	ND
6/14	ND	0.17 (0.32)	ND	ND
6/17	ND	ND (ND)	ND	ND
6/21	ND	ND (ND)	ND	ND
6/24	ND	ND (ND)	ND	ND
6/28	ND	ND (ND)	ND	ND
7/1	ND	ND (ND)	ND	ND
7/8	ND	ND (ND)	ND	ND
7/15	ND	ND (ND)	ND	ND

1. CBD1 Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County.
   CBD5 Colusa Basin Drain at Highway 20 in Colusa County.
   SS1 Sacramento Slough at DWR gauge station in Sutter County.
   BS1 Butte Slough at Highway 20 in Sutter County.

2. Samples collected by the California Department of Fish and Game (CDFG) and analyzed by the CDFG Water Pollution Control Laboratory, Rancho Cordova.

3. ND None detected, limit of detection = 0.05 ppb.

4. Values in parentheses are results of analyses of split samples performed by the California Department of Food and Agriculture, Chemistry Laboratory Services, Sacramento. Limit of detection = 0.05 ppb.

Table 11. Malathion concentrations in Sacramento Valley waterways[1] in 1993[2].

	Malathion (ppb)			
Date	CBD1	CBD5	SS1	BS1
5/3	ND[3]	ND (ND)[4]	ND	ND
	ND	ND (ND)	ND	ND
	ND			
5/10	ND	ND (ND)	ND	ND
		ND (ND)		
5/13	ND			
5/17	ND	ND (ND)	ND	ND
	ND			
5/20	ND	ND (ND)	ND	ND
	ND			
5/23	ND	ND (ND)	0.08	ND
5/27	ND	ND (ND)	0.10	ND
5/31	ND	0.15 (0.17)	ND	ND
6/3	ND	ND (0.08)	ND	ND
6/7	ND	ND (0.06)	ND	ND
6/10	ND	ND (ND)	ND	ND
6/14	ND	ND (0.05)	ND	ND
6/17	ND	ND (0.06)	ND	ND
6/21	ND	ND (ND)	ND	ND
6/24	ND	ND (ND)	ND	ND
6/28	ND	ND (ND)	ND	ND
7/1	ND	ND (ND)	ND	ND
7/8	ND	ND (ND)	ND	ND
7/15	ND	ND (ND)	ND	ND

1. CBD1 Colusa Basin Drain at Roads 109 and 99E near Knight's Landing in Yolo County.
   CBD5 Colusa Basin Drain at Highway 20 in Colusa County.
   SS1 Sacramento Slough at DWR gauge station in Sutter County.
   BS1 Butte Slough at Highway 20 in Sutter County.
   SR1 Sacramento River at Village Marina in Sacramento County.

2. Samples collected by the California Department of Fish and Game (CDFG) and analyzed by the CDFG Water Pollution Control Laboratory, Rancho Cordova.

3. ND None detected, limit of detection = 0.05 ppb.

4. Values in parentheses are results of analyses of split samples performed by the California Department of Food and Agriculture, Chemistry Laboratory Services, Sacramento. Limit of detection = 0.05 ppb.

Table 12. Estimated mass transport of molinate and thiobencarb in the Sacramento River past Sacramento in the years 1982-1993.

Year	Kg (pounds) Transported			
	molinate		thiobencarb	
1982	18,464.9	(40,666.9)	1	
1983[2]	2,752.9	(6,056.5)	623.7	(1,372.2)
1984	7,352.0	(16,174.4)	715.2	(1,573.5)
1985	6,014.8	(13,232.5)	2,317.5	(5,098.6)
1986	4,622.1	(10,168.7)	845.7	(1,860.6)
1987	2,342.3	(5,153.2)	22.8	(50.2)
1988	3,194.2	(7,027.2)	68.1	(149.8)
1989	1,984.1	(4,365.1)	11.4	(25.1)
1990	3,204.1	(7,049.1)	51.4	(113.1)
1991	99.2	(217.9)	0	(0)[3]
1992	56.6	(124.7)	0	(0)
1993[2]	2,006.9	(4,232.4)	0	(0)

1. Mass transport was not calculated due to incomplete monitoring data.

2. The Colusa Basin Drain, a major agricultural drainage canal, did not contribute to the mass transport at Sacramento during all or part of the sampling period because the drain was routed into the Yolo Bypass during unusually high Sacramento River flows.

3. Thiobencarb was not detected in the Sacramento River in 1991 - 1993 (limit of detection = 0.1 ppb).

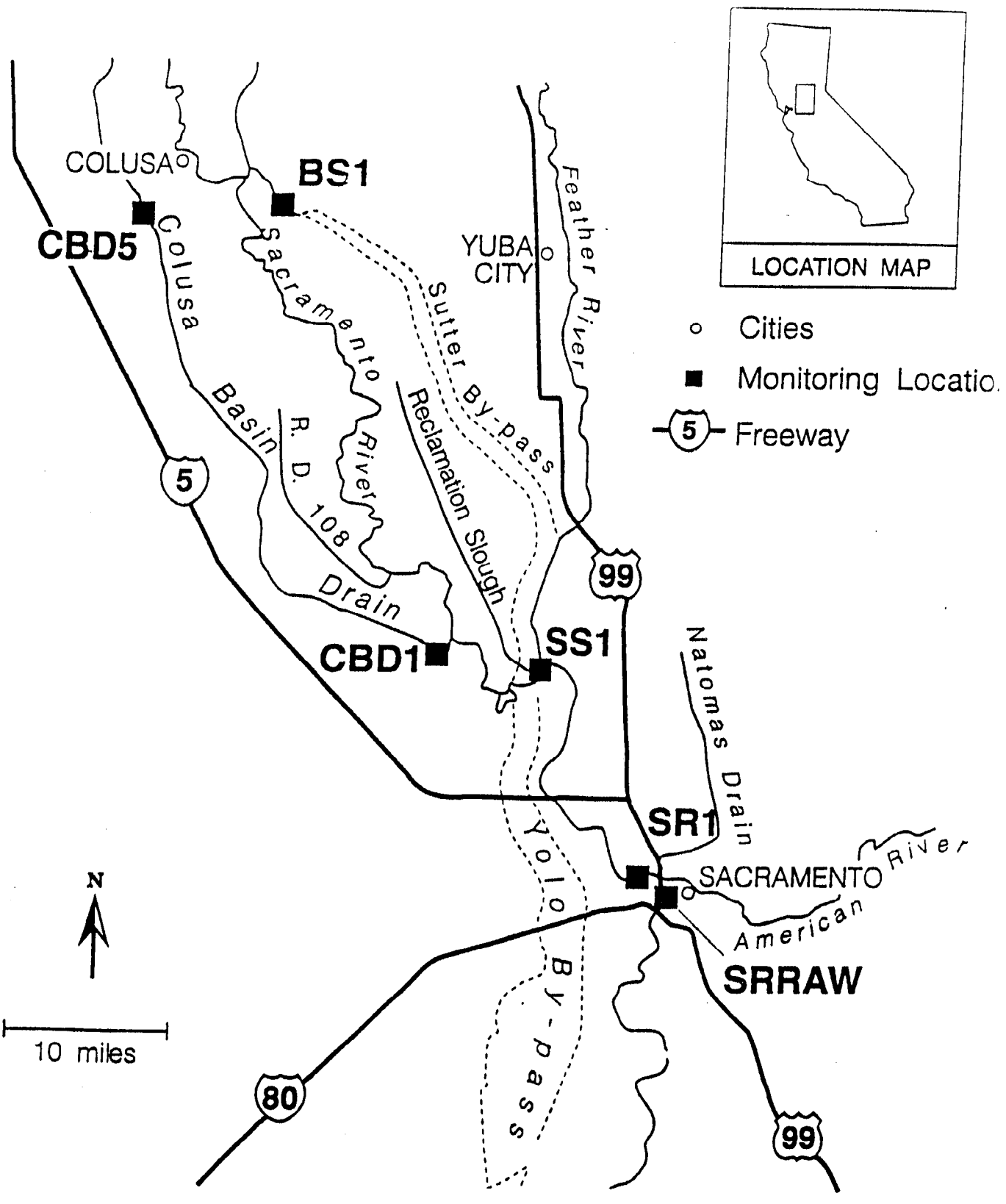


Figure 1: Pesticide monitoring sites in the Sacramento Valley.

Figure 2: Average and greatest rainfall received at Colusa, CA on days with measurable rainfall (May 10 - June 15, 1951 - 1992) and rainfall in 1993.

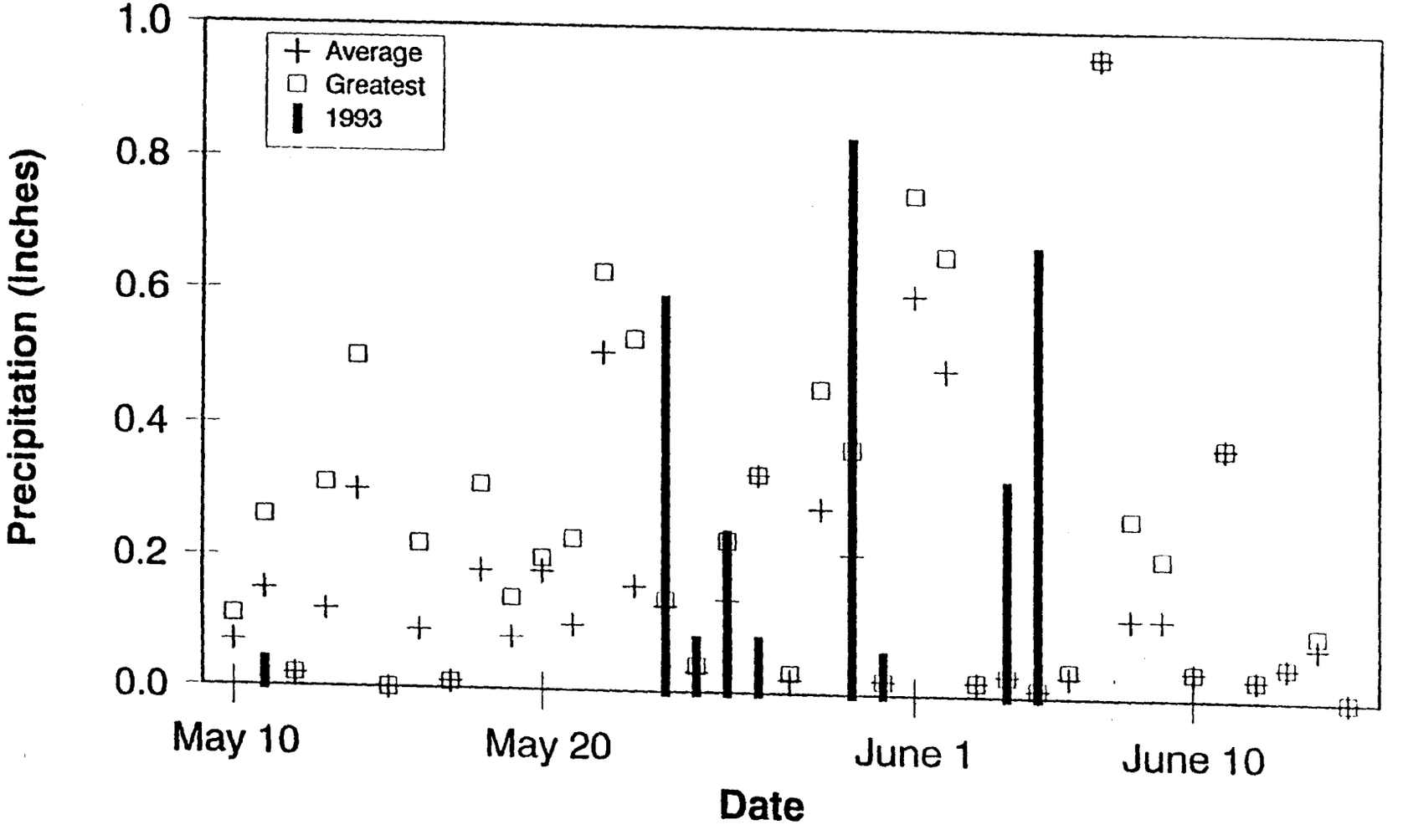


Figure 3: Maximum and minimum temperatures recorded in Colusa, CA on May 1 - June 30, 1993 compared to historical (1951 - 1992) averages.

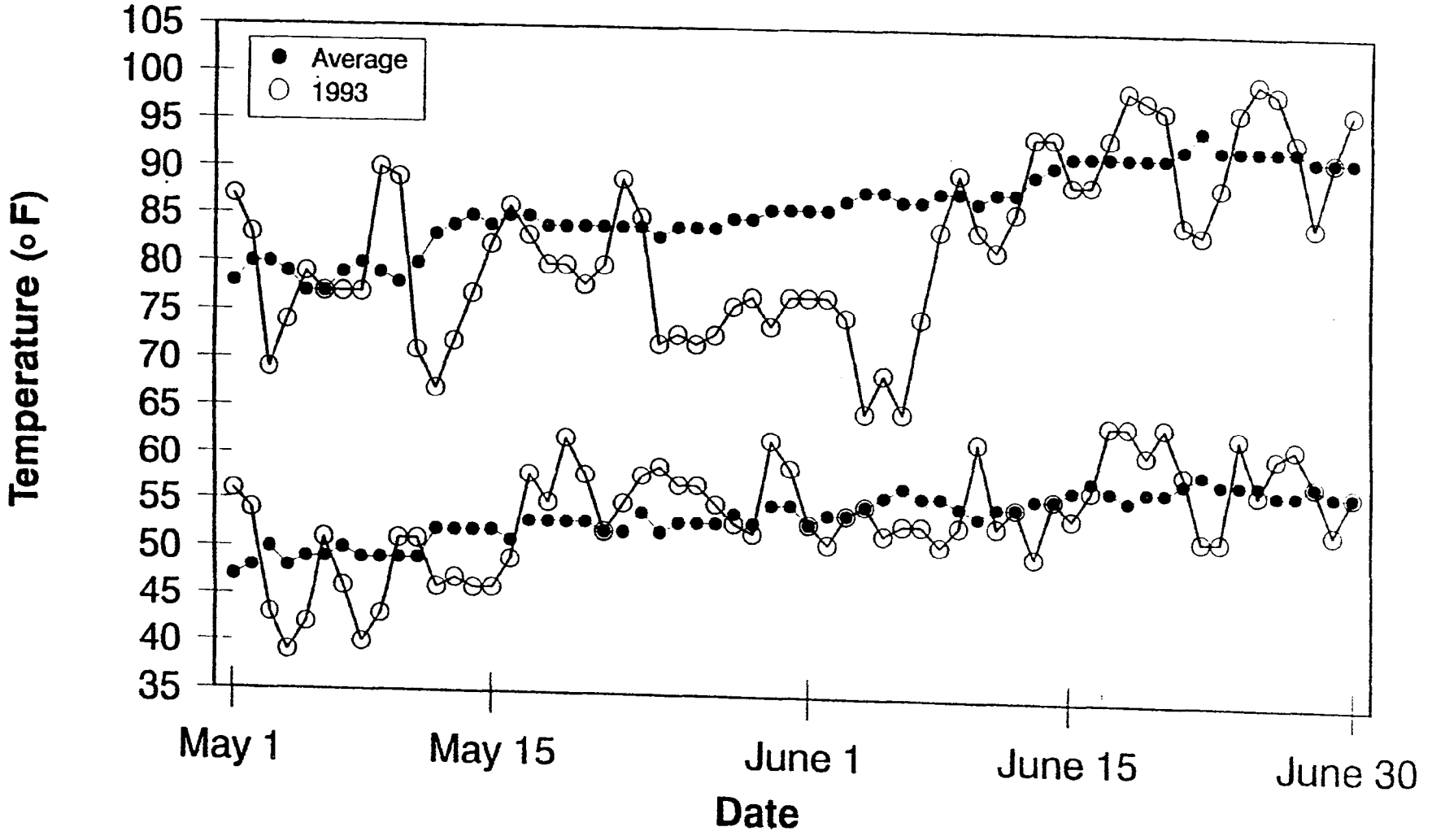


Figure 4: Rainfall received at Colusa, CA and emergency releases issued in the Sacramento Valley from May 1 - June 30, 1993.

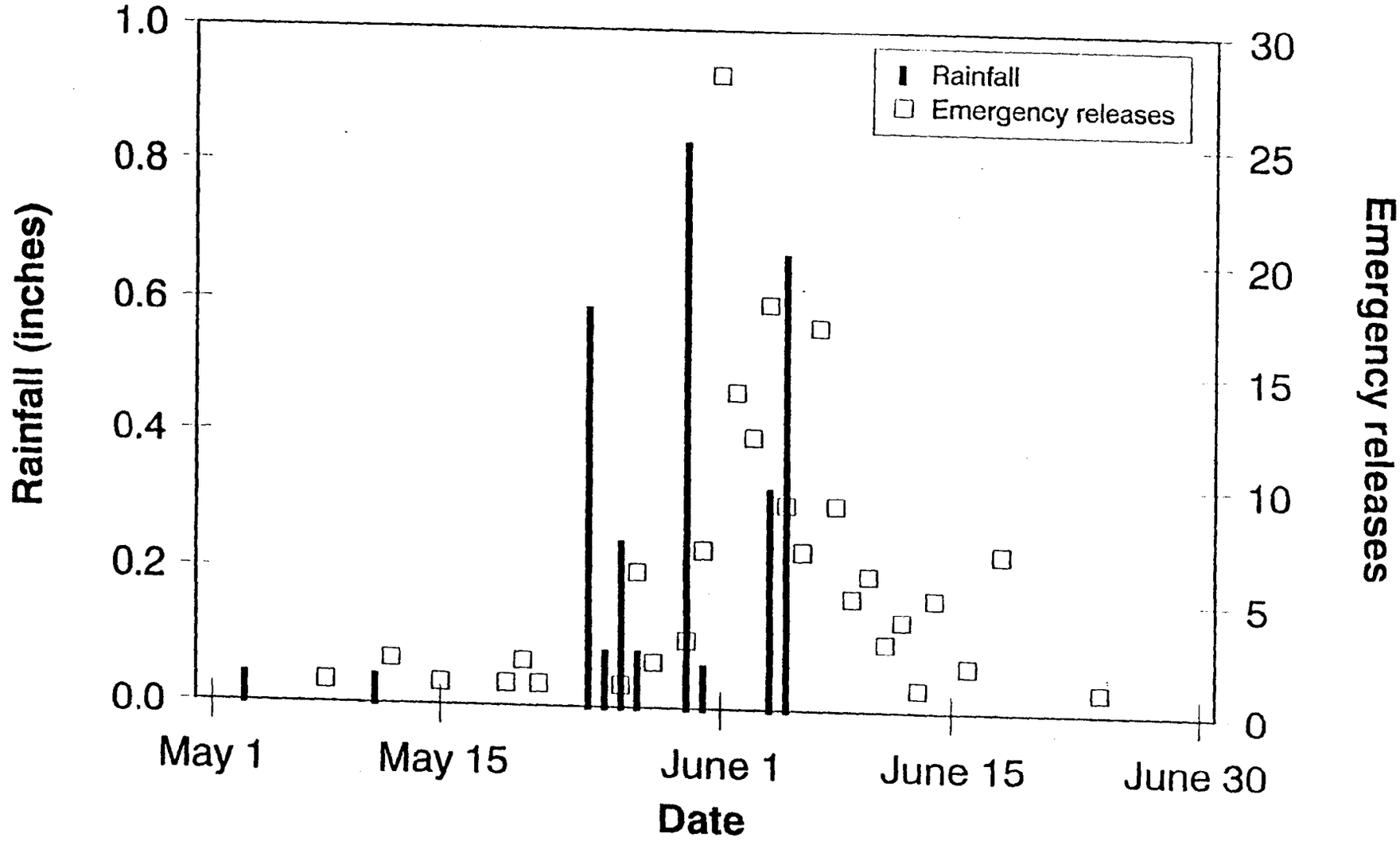


Figure 5: Acres treated with molinate in Colusa and Glenn Counties and concentrations of molinate in the Colusa Basin Drain near SR20 in 1993.

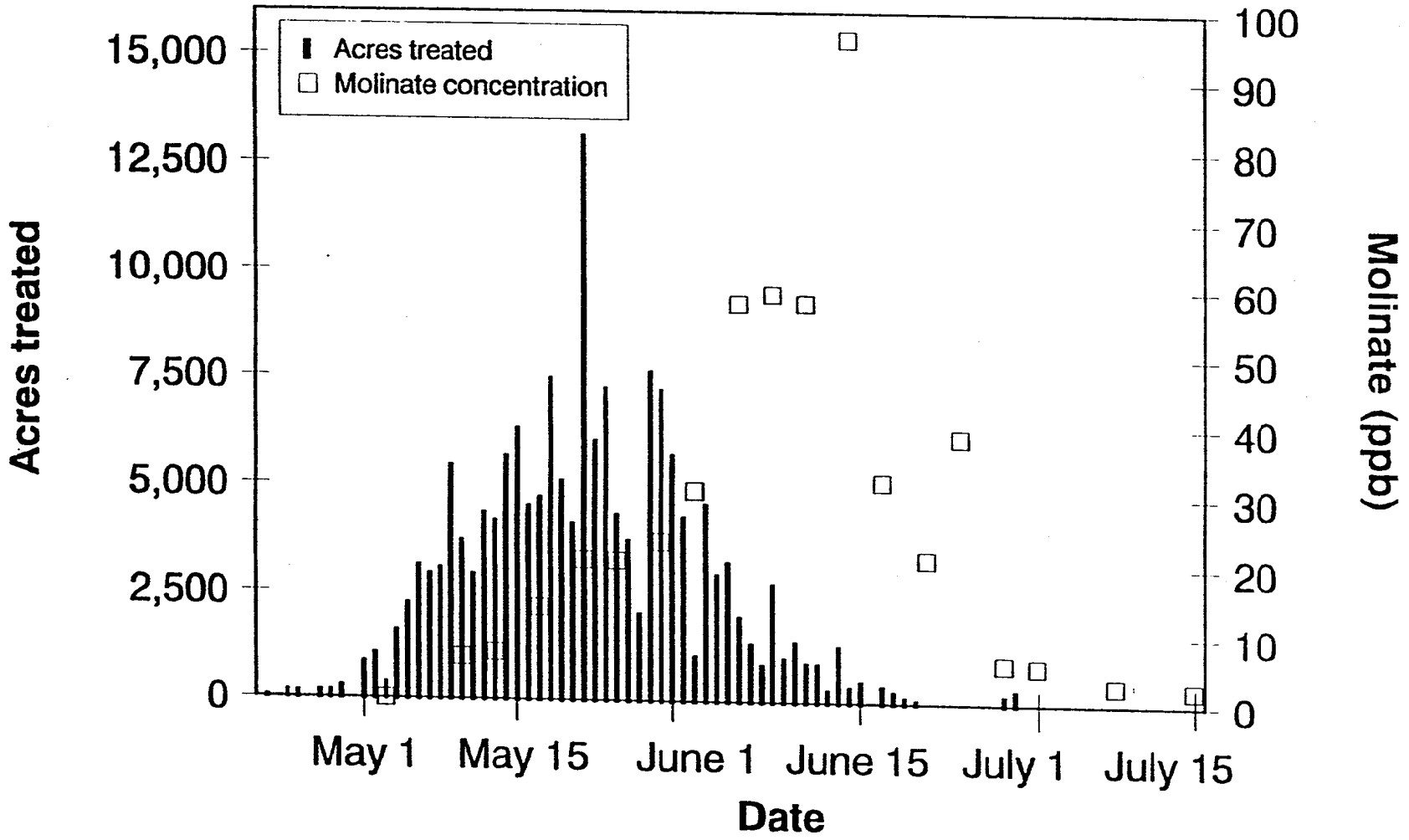


Figure 6: Acres treated with molinate in Butte County and concentrations of molinate in Butte Slough in 1993.

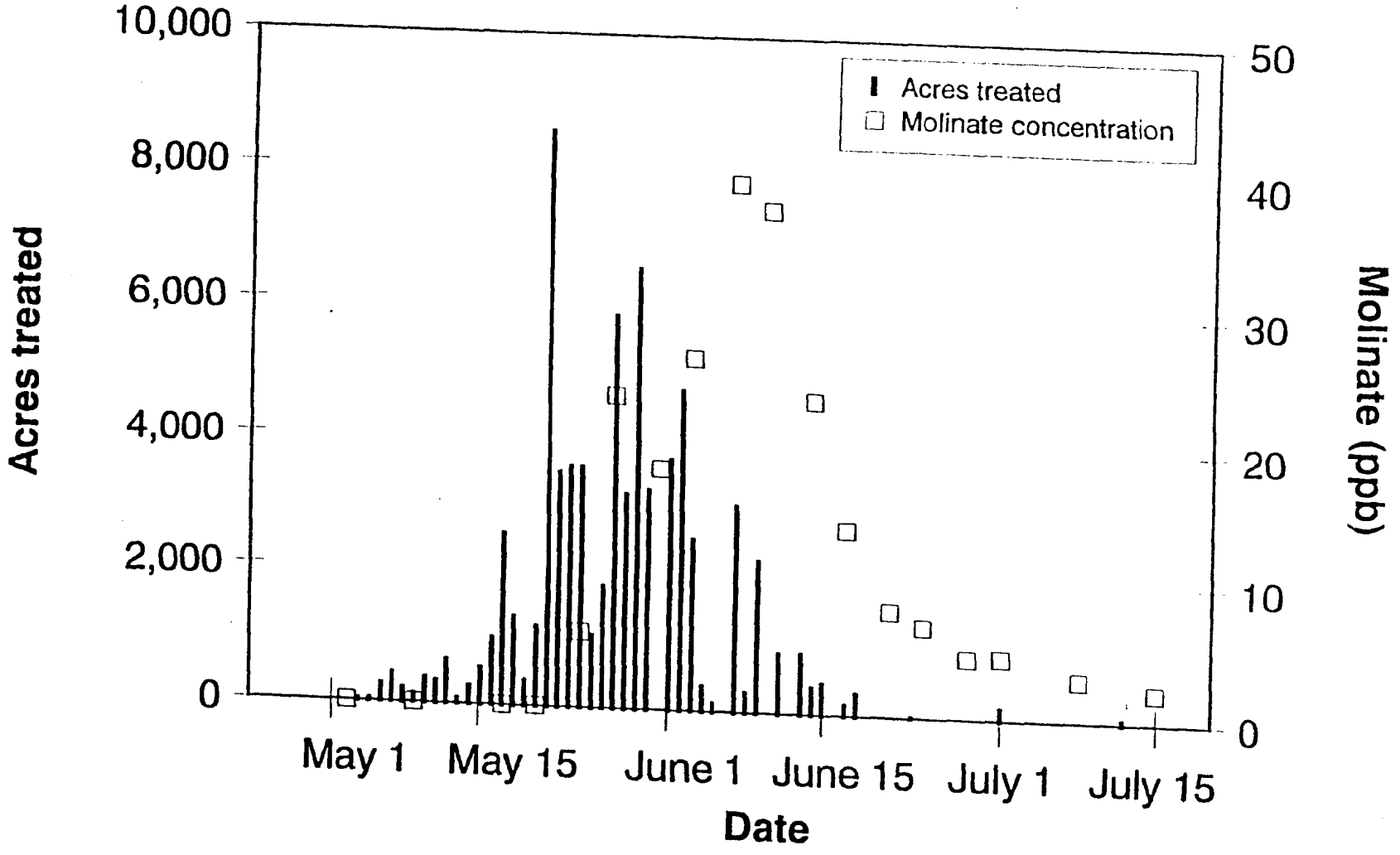


Figure 7: Acres treated with thiobencarb in Colusa and Glenn Counties and concentrations of thiobencarb in the Colusa Basin Drain near SR20 in 1993.

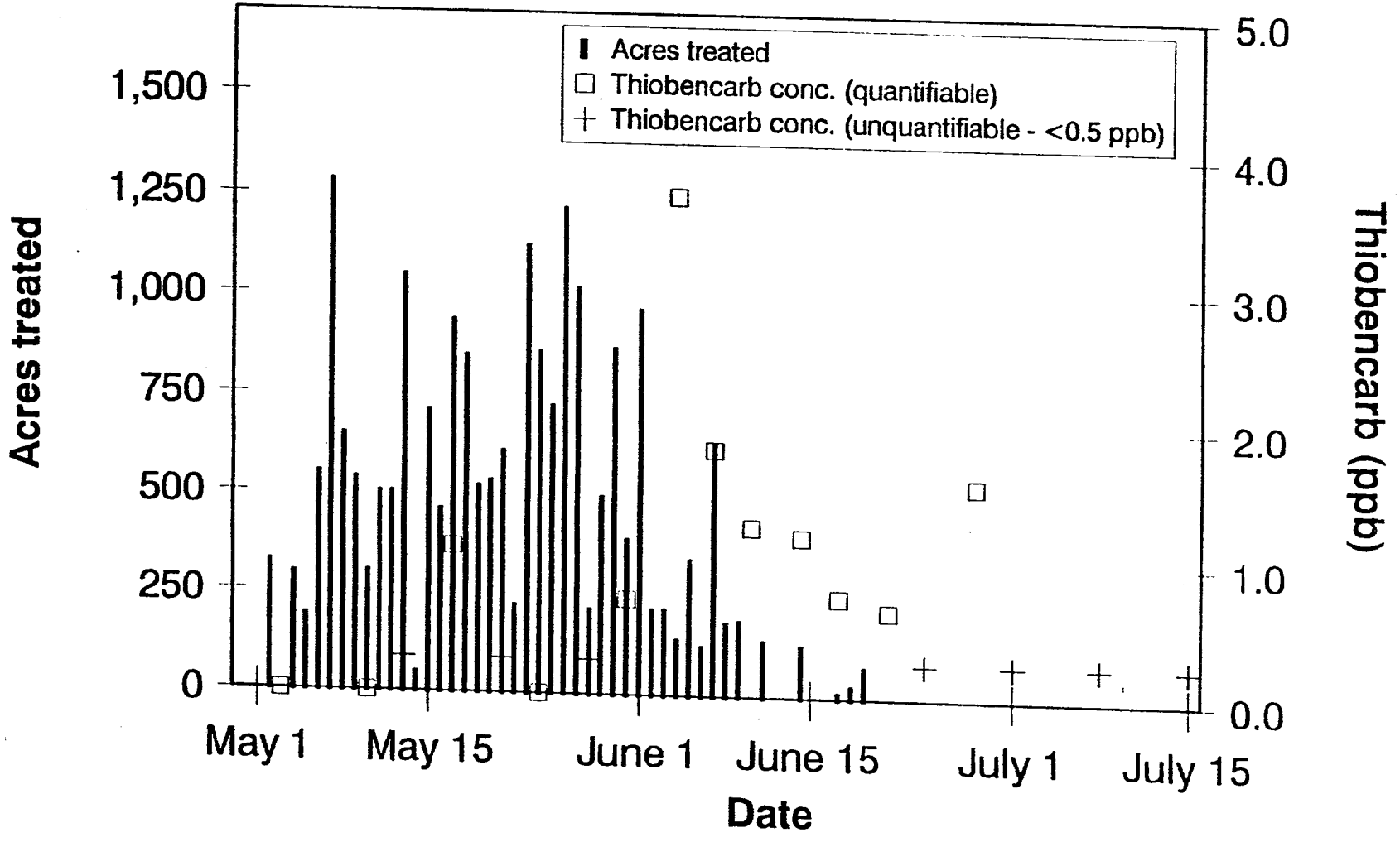


Figure 8: Acres treated with carbofuran in Butte County and concentrations of carbofuran in Butte Slough in 1993.

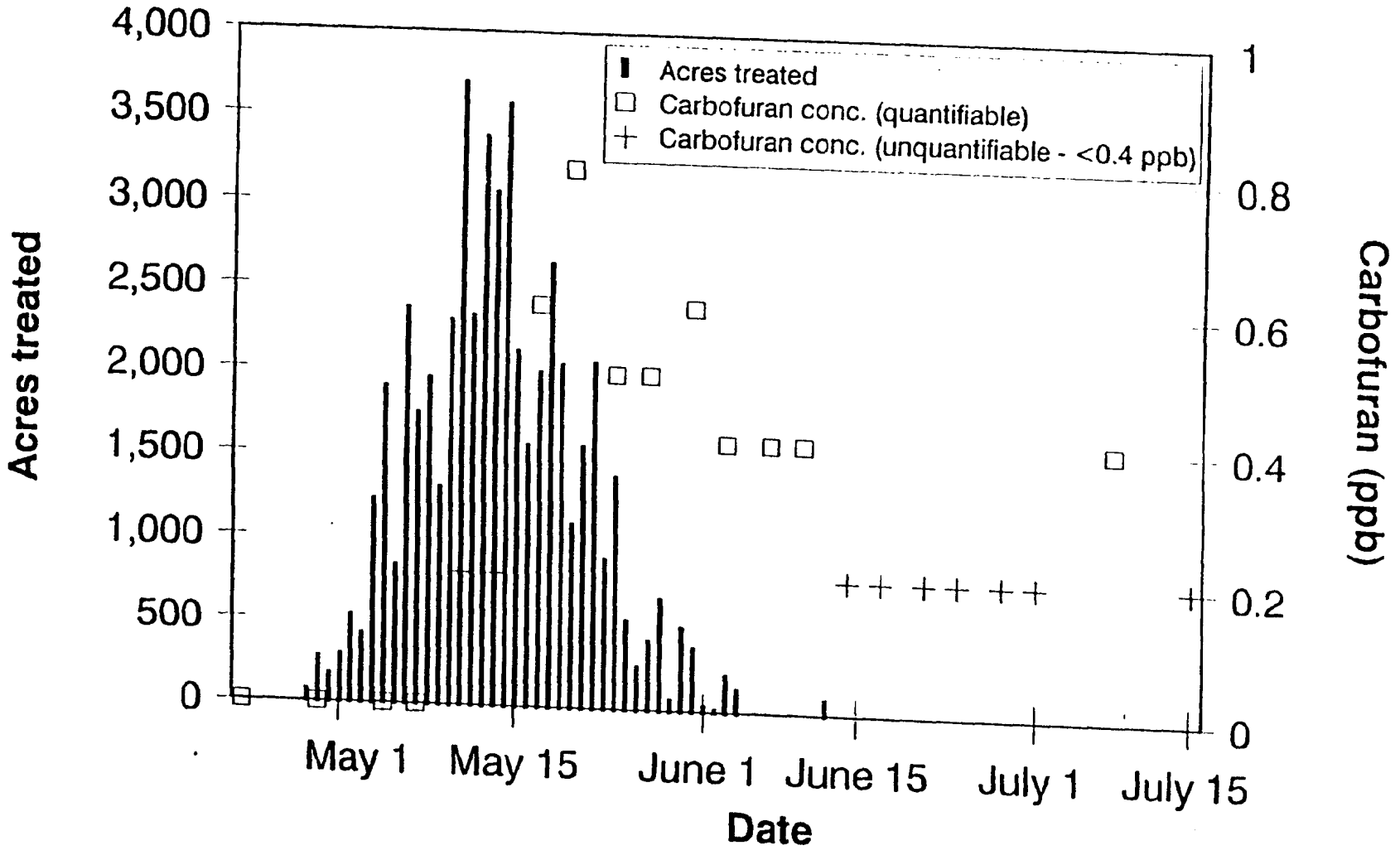


Figure 9: Acres treated with carbofuran in Colusa and Glenn Counties and concentrations of carbofuran in the Colusa Basin Drain near SR20 in 1993.

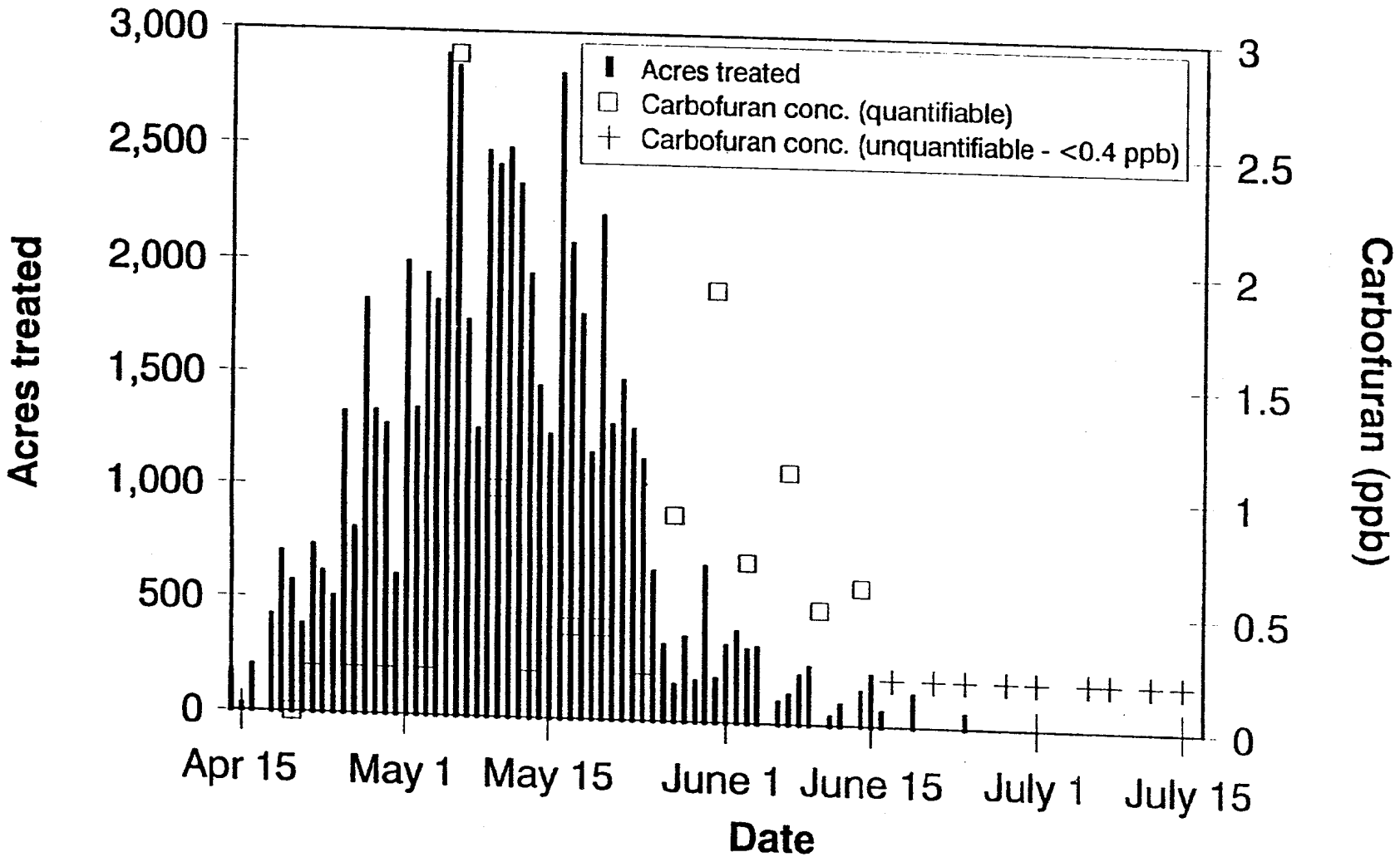
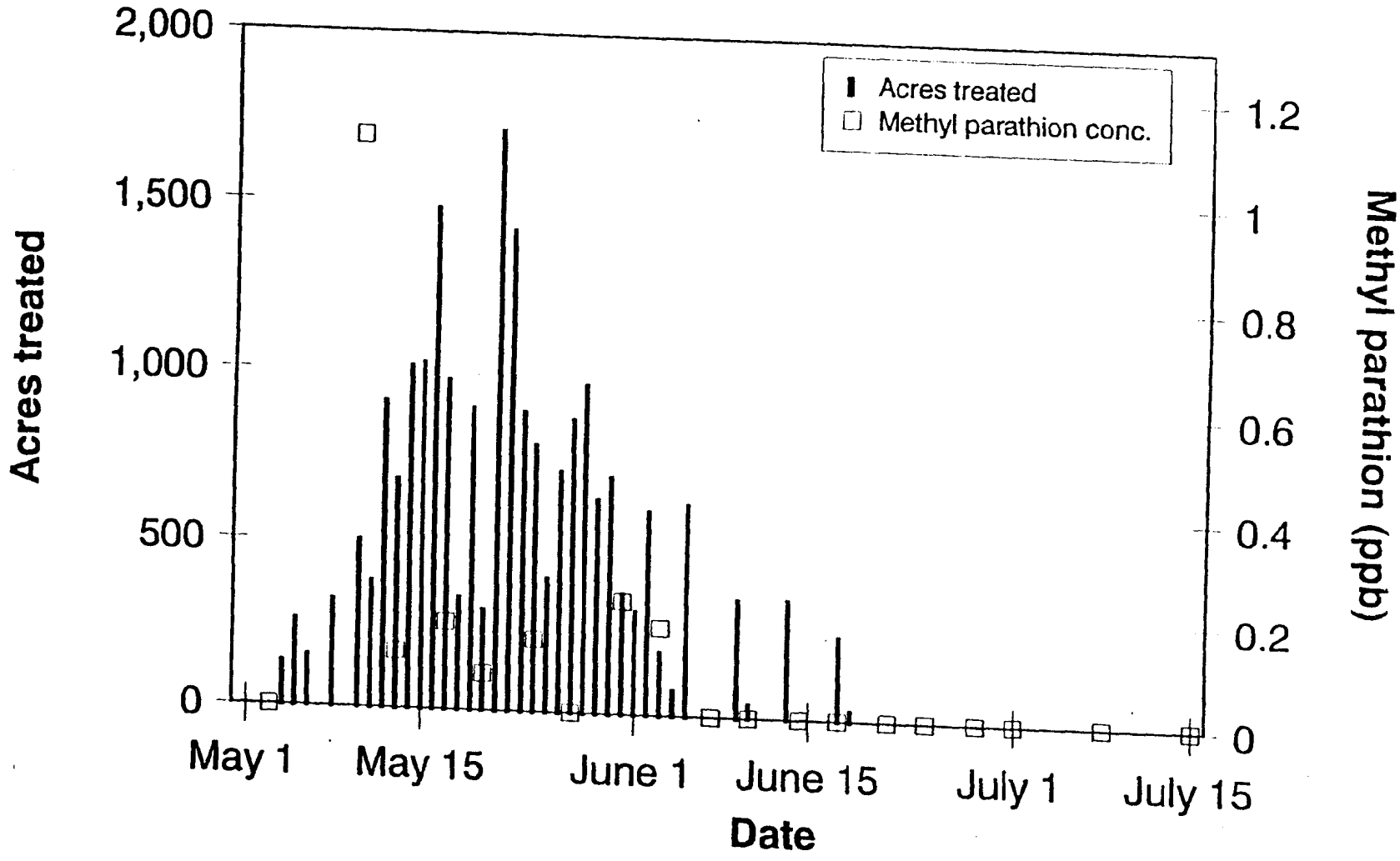


Figure 10: Acres treated with methyl parathion in Colusa and Glenn Counties and concentrations of molinate in the Colusa Basin Drain near SR20 in 1993.



Appendix 1

FURADAN (Carbofuran), METHYL PARATHION, AND ORDRAM (Molinate)

EMERGENCY RELEASE

Grower:_____ Permit No.:_____

Address:_____ Zip:_____

Field location:_____ Site No.:_____
(Attach detailed map)

Chemical applied:_____
Rate of application:_____
Date of application:_____
Average water depth_____
at time of application:_____

Chemical applied:_____
Rate of application:_____
Date of application:_____
Average water depth:_____
at time of application:_____

Chemical applied:_____
Rate of application:_____
Date of application:_____
Average water depth_____
at time of application:_____

Chemical applied:_____
Rate of application:_____
Date of application:_____
Average water depth_____
at time of application:_____

Starting date of emergency release:_____

Acres in field:_____ Laser leveled? Yes_____ No_____

Type of irrigation system: Flow through_____ Recycle_____ Static_____ Other_____

Date flooding began:_____ No. of days it takes to fill field:_____

Describe problem that led to emergency release: _____
_____
_____
_____

Steps that can be taken to prevent emergency releases from this field in future years:
_____
_____
_____

Recommendation (attached) by:_____

Applications by:_____

Grower's signature: _____ Date: _____

Approved by: _____
Agricultural Biologist

Appendix 2

EMERGENCY RELEASE FORM

Grower: _____ Permit No.: _____

Address: _____ Zip: _____

Field location: _____ Site No.: _____

Beginning date of release: _____ Ending date: _____

The grower must determine the amount of water discharged during the emergency release period. To do this, measure the width of each weir opened to allow the discharge. Then, on a daily basis, measure the height of water flowing over each weir. Record all information in the table below.

Weir 1		Weir 2		Weir 3	
Width:		Width:		Width:	
Date	Height of water	Date	Height of water	Date	Height of water

Appendix 3

1994 MALATHION USE

The Central Valley Regional Water Quality Control Board has approved a water management practice following malathion use in rice that will help meet 1993 water quality performance goals for malathion in surface water. Malathion is currently not a restricted material and not subject to use requirements or permit conditions. However, it is important that growers comply with this practice.

Water treated with malathion should be held on the site of application for at least four days following application.

Water quality monitoring will be conducted in 1993 to determine the adequacy of this practice in managing malathion discharges. If malathion levels do not adequately meet the performance goal, a more formal regulatory program may be implemented in future years.

TITLE 3 - CALIFORNIA CODE OF REGULATIONS

Section 6460. Drift Control.

Unless expressly authorized by permit issued pursuant to section 6412, no liquid herbicide specified in subsection (m) of section 6400 shall be:

a) Discharged more than ten feet above the crop or target. Discharge shall be shut off whenever it is necessary to raise the equipment over obstacles such as trees or poles.

b) Applied when wind velocity is more than ten miles per hour.

c) Applied by aircraft except as follows:

(1) The flow of liquid to aircraft nozzles shall be controlled by a positive shutoff system as follows:

(A) Each individual nozzle shall be equipped with a check valve and the flow controlled by a suckback device or a boom pressure release device; or

(B) Each individual nozzle shall be equipped with a positive action valve.

(2) Aircraft nozzles shall not be equipped with any device or mechanism which would cause a sheet, cone, fan, or similar type dispersion of the discharged material except as otherwise provided.

(3) Aircraft boom pressure shall not exceed 40 pounds per square inch.

(4) Aircraft nozzles shall be equipped with orifices directed backward parallel to the horizontal axis of the aircraft in flight.

(5) Fixed wing aircraft and helicopters operating in excess of 60 miles per hour shall be equipped with jet nozzles having an orifice of not less than 1/16 inch in diameter.

(6) Helicopters operating at 60 miles per hour or less shall be equipped with:

(A) Nozzles having an orifice not less than 1/16 inch in diameter. A number 46 (or equivalent) or larger whirlplate may be used; or

(B) Fan nozzles with a fan angle number not larger than 80 degrees and a flow rate not less than one gallon per minute at 40 pounds per square inch pressure (or equivalent); or

(C) The Microfoil® boom (a coordinated spray system including airfoil-shaped nozzles with each orifice not less than 0.013 inches in diameter) or equivalent type approved by the director. Orifices shall be directed backward parallel to the horizontal axis of the aircraft in flight.

(d) Applied by ground equipment except as follows:

(1) Ground equipment other than handguns shall be equipped with:

(A) Nozzles having an orifice not less than 1/16 inch in diameter or equivalent, and operated at a boom pressure not to exceed 30 pounds per square inch; or

(B) Low pressure fan nozzles with a fan angle number not larger than 80 degrees and fan nozzle orifice not smaller than 0.2 gallon per minute flow rate or equivalent, and operated at a boom pressure not to exceed 15 pounds per square inch.

1994 THIOBENCARB PROGRAM

I. Fields north of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County.

A. Fields treated with all products (except Abolish 8EC using the "preflood surface" method) - water must be retained on the treated field for 30 days following application unless:

1. the water is contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 20 days following the last application within the system.

a. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

b. If the system includes drainage from more than one permittee, treated water may be discharged from the application site into the system 7 days following application.

2. the fields are within the bounds of specific geographic areas that discharge negligible amounts of rice field drainage into the Sacramento River or its tributaries until fields are drained for harvest. All water on fields treated with thiobencarb must be retained on the treated acreage for at least 6 days following application.

B. Fields treated with Abolish 8EC using the "preflood surface" method - water must be retained on the treated fields for at least 19 days following application unless:

1. the water is contained within a tailwater recovery system, ponded on fallow land, or contained in other systems appropriate for preventing discharge. The system may discharge 20 days following the last application within the system.

a. If the system is under the control of one permittee, treated water may be discharged from the application site in a manner consistent with product labeling.

b. If the system includes drainage from more than one permittee, treated water may be discharged from the application site into the system 7 days following application.

2. the water is on fields within the bounds of specific geographic areas that discharge negligible amounts of rice field drainage into the Sacramento River or its tributaries until fields are drained for harvest. All water on fields treated with thiobencarb must be retained on the treated acreage for at least 6 days following application.

II. Fields south of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County - water must be retained on the treated fields for at least 6 days following application.

III. When discharges resume from fields that did not qualify for shortened holding times as provided in I.A., I.B., and II. above, discharge volumes shall not exceed 2 inches of water over a drain box weir. Unregulated discharges from these fields may then resume after 7 days.